BEFORE THE

CALIFORNIA ENERGY COMMISSION

In the Matter of	) Docket No. 14-IEP-1B
	)
2014 Integrated Energy Policy	)
Report Update (2014 IEPR Update)	)

LEAD COMMISSIONER WORKSHOP ON
CLIMATE CHANGE IMPACTS ON THE
TRANSPORTATION SYSTEM

CALIFORNIA ENERGY COMMISSION
HEARING ROOM A, 1516 NINTH STREET
SACRAMENTO, CALIFORNIA

WEDNESDAY, MAY 28, 2014
3:00 P.M.

Reported by:
Peter Petty

APPEARANCES

Commissioners Present (*Via WebEx and telephone)

Janea A. Scott, Lead Commissioner for the 2014 IEPR Update
Lead Commissioner on Transportation

Robert Weisenmiller, Chair

Karen Douglas

CEC Staff Present

Heather Raitt

Moderator

Ann Chan, California Natural Resources Agency

Presenters (* via WebEx)

*John Radke, UC Berkeley
Robert Lempert, RAND Corp.

Also Present:

Public Comment

Martine Schmidt-Poolman, UC Berkeley

I N D E X

P R O C E E D I N G S

MAY 28, 2014 3:03 p.m.

MS. RAITT: Welcome to the Lead Commissioner Workshop on Climate Change Impacts on the Transportation System. This workshop is part of the 2014 IEPR Update.

I'm Heather Raitt, lead for the IEPR. And I'll begin by going over a couple of housekeeping items.

If there's an emergency and we need to evacuate the building, please follow staff to Roosevelt Park, which is across the street diagonal to the building, and wait there until it is safe to return.

Today's workshop is being broadcast through our WebEx conferencing system and parties should be aware that you're being recorded. We'll post an audio recording on the Energy Commission's website in a few days and a written transcript in about three weeks.

We have one panel today, moderated by Ann Chan of the California Natural Resources Agency, and we'll discuss the Draft Report Safeguarding California, Reducing Climate Risk. Unfortunately, one of our planned speakers for the panel, Deb Niemeier, is ill and she won't be able to make it and sends her regrets. We plan to be posting her slides tomorrow.

We have two presenters today, John Radke from UC Berkeley on WebEx, and Robert Lempert from RAND Corporation. And at the end of the panel, there will be an opportunity for public questions and comments.

For those who would like to make comments, we are requesting that you keep your comments limited to three minutes, and we'll take comments first from those in the room, and then from people participating by WebEx. And for WebEx participants, you can use the chat function to tell our WebEx Coordinator that you'd like to ask a question or make a comment during the public comment period and we'll either relay your question or open your line at the appropriate time. For any phone-in participants, we'll open your lines after we've taken comments from in-person participants and WebEx participants.

Materials for the meeting are available at the table when you walked in and are also available on our website. We encourage folks to provide written comments as well, and request that those be submitted to us by June 11th, and the Notice for the meeting provides information about the process for submitting comments.

With that, I'll turn it over to the Commissioners. Thank you.

COMMISSIONER SCOTT: Thank you, Heather. Good afternoon and welcome to everybody. Thank you for joining us for today's workshop on Climate Change Impacts on the Transportation System. I am very much looking forward to hearing the presentations from our presenters today; I'm sorry to hear that Deb Niemeier is sick and hope that she feels better soon.

And I'd just like to say welcome to our presenters that we do have here in the room and on the phone. And I will turn to Chair Weisenmiller to see if he has any opening remarks.

CHAIRMAN WEISENMILLER: Yeah. I certainly want to thank everyone today for being here. I think we're all becoming more and more familiar that our climate is being disrupted and that comes from the high greenhouse gas emissions. So transportation is really great, we can focus on it, and that about 40 percent of our greenhouse gas emissions in California are from transportation. And at the same time, these changes are affecting our transportation system. And so, as we plan that critical infrastructure, we look at what the implications are of climate change in that planning. So, again, thanks everyone for being here today.

COMMISSIONER SCOTT: Great. So I will turn it over to Ann Chan, welcome, from the Natural Resources Agency. And thank you for joining us and I'll let you kick it off.

MS. CHAN: Thank you so much. I'm Ann Chan, I'm the Deputy Secretary for Climate Change and Energy at the California Natural Resources Agency.

The California Natural Resources Agency actually leads the development of a report called "Safeguarding California: Plan for Reducing Climate Risks in California" and there you see a copy of the document. We put out the first draft back in December of 2010 and it does include a chapter on Transportation and Risks to Transportation from Climate Change, and the lead for that section of the document was actually Caltrans, one of our sister agencies. So that's why I'm here helping to moderate this panel today.

I'd like this to be a little bit of an interaction discussion, so what I was hoping to do was just take a few minutes here to give you a little bit of an overview of the materials in the Safeguarding California Plan on Transportation, and then we'll hear from our panelists and then I'd like to reserve a little bit of time before we open up the official Q&A to do a little bit of interactive back and forth with our two panelists, and have some inter-panel discussion if that makes some sense.

So as folks may know, there are a myriad of climate risks that California is facing and we know this in part because California has invested in regionally relevant climate science in California through three prior California Climate Change Assessments. We are currently thinking about a fourth Climate Change Assessment, the Governor has $5 million allocated in his Proposed Budget for a fourth California Climate Change Assessment and the Legislature is still discussing that funding as we speak now in conference this week.

Some of the risks we know we face are things like extreme storm events, sea level rise, heat and flooding, and all those things can have impacts on the transportation system and also on the supporting systems, namely the energy and fuel systems that support the transportation systems. So sometimes people forget about how those different systems are interrelated and it makes a lot of sense to be having this discussion here at the Energy Commission.

Obviously, the transportation system is really multi-modal. We not only have highways and roads, but we also have rail transit, ports and airports, and California is rich in all those different types of modes. I think one of the challenges with having that kind of a multi-modal system is that not all of those assets are under State jurisdiction, so when we're thinking about State policy efforts to prepare for climate impacts to the transportation system, we really need to figure out how to enhance our coordination between federal, state, local and private entities, as well, because there are many transportation assets under private management, as well.

So the Safeguarding California Plan, if you're interested in this topic, really goes into some depth about expected impacts on the transportation system, what we've done to date, and our recommendations for what to do to help reduce those risks. We had an extensive public comment period and we are in the process of finalizing the document and expect it to be out this summer.

The stakes are very high obviously when we're talking about climate impacts to the transportation system. Transportation system not only supports our economy, but also personal mobility and emergency services. I think Super Storm Sandy really brought this into focus for a lot of people and eliminated some of these issues in a way that people hadn't thought about before, that it's not just you worry about roads, you also worry about your transit systems.

It's not enough just to get fuel to your car, you need to have energy to make sure that you can run the pumps to get the fuel into your car. So it's very timely, an interesting topic, and really looking forward to hearing from our panelists.

I think on the agenda our first speaker is John Radke. He’s an Associate Professor at U.C. Berkeley and he’s joining us by WebEx, I believe. And his research focuses on analytical methods imbedded in GIS or Geographic Information Science. And his interests include the development of metrics that assist scientists and professionals in recognizing spatial structures and changes in complex landscapes. These metrics really help us to advance our ability to classify and make sense of data generated by sophisticated sensors that record a map’s spatial distribution of phenomena beyond human comprehension.

So I know this is an area of great interest also to the Federal Government. We’ve been spending a lot of time as the State of California talking with our Federal counterparts about how to take climate data and make it accessible through tools, mapping and visualization for folks so that they can really start using it to help with planning efforts to reduce climate risks.

And so with that introduction, I think I’m going to turn it over to John.

PROFESSOR RADKE: Now I need to -- can

everyone see my slides?

COMMISSIONER SCOTT: We can hear you. I think they're queuing up your slides right now.

PROFESSOR RADKE: Well, I'd like to show them from my desktop because I have –

COMMISSIONER SCOTT: Yeah, go ahead and share your desktop.

PROFESSOR RADKE: It should be happening, right? Can you see it?

COMMISSIONER SCOTT: Yes.

PROFESSOR RADKE: Okay, well, so everything you said was really good because it's the kind of area that we've been working on and we have quite a lot of concerns here. My co-PI is Greg Biging and he's from the Environmental Science Policy and Management Group on the campus, and then Howard Foster, Emery Roe, Martine Schmidt-Poolman are all experts in the Center for Catastrophic Management. And then a number of graduate students in various departments, Landscape Architecture, Environmental Planning, and Geography.

And I wanted to mention to everyone, in the wide background that we cover, because we look at lots of complex problems and especially in the Center for Catastrophic Risk Management, which was formed here after Hurricane Katrina, so certainly have been on top of all of the disasters that have come along, and certainly climate change is exacerbating many of those.

Today I'm going to talk about two projects that we're doing and I've sort of melded the two together, and I also talk about some of the modeling that we're doing because the modeling has been evolving. And it's been evolving partly out of an interest that the California Energy Commission has, a suggestion to make it more dynamic, but also out of interest by a lot of the people that control and own infrastructure and have expressed concerns, so we've met with a lot of them as well.

Sea level rise, and hopefully I'm preaching to the converted here, this is coming from Dan Cayan, says that by 2100 it will be a 1.41 meters rise in sea level in the Bay Area, and he said that earlier this year. People are generally worried about areas that fall within the sea level rise borders and that's important. I know that the Governor had mentioned earlier airports and, of course, we did the study looking at San Francisco Airport and the Oakland Airport, and they are stressed by the year 2100. And so something has to be done to protect those. And you'll see by the end of my presentation here that there are some other areas of transportation infrastructure that not only are stressed, but actually get inundated and are probably not savable without some serious rethinking, possibly rethinking the design and location, or rethinking how we're going to defend them.

All right, so here is a picture of a storm. This is not a 100-year storm event, it's far less than that. It's out on Sherman Island, it's out on the levee, and the picture on the right-hand side is Hamilton Field and you'll see the purple lines happen to be the gas pipelines running through the area, and the yellow lines happen to be the highway infrastructure. And you can see the roads, as well, in that picture and you'll see later on, this next picture on the left is a truck driving along the levee, you can just barely see it, it's being inundated by that less than 100-year storm event, which means the infrastructure and the road transportation systems being impacted, and you'll see later that the levees can get impacted, and what the repercussions of that on the transportation system are.

On the right-hand side, what you're seeing is Hamilton Field inundated and you're seeing that both roads, houses, and the gas pipeline infrastructure is impacted.

So but not just inside where the sea level will rise, but we have to look outside that area because it will also be affected, and that's what I've tried to point out on several talks that I've given, that those that live outside the area may feel they're not going to be impacted, but in fact they are.

There is this domino effect of things that are interconnected, interdependent infrastructure. And this is a diagram by Don Boland, the Executive Director of California Utilities Emergency Association (CUEA). And we see this, all of these infrastructure transportation up in the right-hand side, but they're all affected -- natural gas, telecom, electrical power. And when one is stressed, or one starts to degrade, or is broken, the other ones are affected by it.

And the transportation study we completed for the Bay Area, and I'll be talking about that, and I'll also be talking about the present study that we're doing on the gas pipeline vulnerability. Both projects look at inundation. And it's been sort of an ongoing effort on our part to try to get this right and becoming as accurate as we can because, of course, we've been flooding the Bay Area for a long time using different models. And in our transportation model, we looked at sea level rise, and we looked at increments of no sea level rise to .5 meter, 1.0 and 1.4. Notice earlier, I said Dan had suggested that by the end of the century, it will be at 1.41, and that's an adjusted mark, and that may be adjusted even further given what we learn every day. But for this transportation study, it was 1.4, and so we just took that one as a benchmark.

We add the 100-year extreme storm event, and this is an event that comes along once every 100 years, but in some of Cayan's recent and Bromirski's recent research, they've shown that this event will start to repeat itself until by the year 2100, it comes back every year so it's no longer a 100-year storm event.

Then we use a pathway model rather than a bathtub model, and the pathway model we used because it shows us that some people predicted with their models using a bathtub that this would be the inundation in the North Bay and, of course, we using a pathway, we realized that levees are quite effective and keep the water out. And so we used this pathway model in our transportation study and we moved on to different models that we're using today, as well.

Both projects look at inundation and the Gas Pipeline Vulnerability Study, it looks at the same rise in sea level; we add to that a near 100-year storm event, and I'll explain why we're using a near 100-year and not a predicted 100-year storm event, but in this model, in this more recent research we're using a dynamic process and it incorporates Diurnal tides and Peak water levels during storm events, and so we actually rather than running the model once and looking at sea level rise and predicted height of wave, we look at the pounding of the waves against the shore and we look at how much they go inland and how much they retreat. And it turns out, through our discussions with some operators of gas pipelines that this is quite a concern of theirs because some of the infrastructure was not originally built to deal with their pipelines being under water for certain extended lengths of time. So it turns out that water movement and water depth are quite important. When we first started the project, we weren't concerned about that, we were more concerned about swelled failure, and I think that was brought on by some accidents that had occurred earlier and by some of the information that had come out of Katrina and some of the decisions they made in Katrina to change infrastructure. But we've now been sort of enlightened and we realize that the amount of water and how it's sloshing throughout and on top of some of these infrastructures is quite important.

Of course, looking at the Improvement of Inundation model, we're starting to model the movement through the different gauging stations and some of them we predict from using an inundation model, and some of them are real data. So we've been able to calibrate our model.

So let me just show this movie and this

is near Mission Bay and it's over a 24-hour period, and this is the sea level has risen 1.4 meters and we're at a near 100-year storm event, and I'll explain a little bit about that later. But as you see here, the water came in and inundated the land, and then it started to recede. But hopefully you can see my cursor. Can you see my cursor, the little hand?

MS. CHAN: Yes.

PROFESSOR RADKE: And this is the end of the high speed rail line, I believe, and of course over here is U.C. San Francisco, and we see remnants of water still left, so this area has been flooded. And during the movie, the water went inland and then came out again, so things further inland were impacted.

So this new way of modeling is telling us how it's going to hit the landscape and how it's going to move on land, but we're seeing transportation infrastructure and pretty critical transportation infrastructure, and then just regular infrastructure being impacted by it.

All right, so components to estimate our potential inundation areas, and that actually takes an awful lot to do this because we're not doing this at low resolution, we're doing this for the entire Bay Area, the Delta, and we're heading down the coast. And for the Bay Area and Delta, we've been modeling it at one meter resolution, but we've taken data from Lidar and some of the point clusters are every few inches, and you'll see some examples of this. It's kind of hard to see, to show results on a screen because we do it at such a high resolution, and it's pretty hard to fit it onto a screen.

We model the sea level rise through four iterations, and we do this because the circulation models show us that 1.4 meters is likely going to be what's happening at the end of the century. We entered the 100-year extreme storm event and for the transportation model we did this one in the upper right-hand corner 2.6 as the hundred-year storm event, and that was the theoretical one, and we actually modeled that for the transportation. But for the gas project that we're on now, we're modeling it at something that is close to a 100-year storm event, and I'll explain the reason why we chose this 1998 storm event. We need to calibrate our models. And if we look over the 100-year extreme storm events, we find that there are some peaks, and we see one in ’82-’83, and we see a peak in ’97-’98, but those were El Nińo years. And we chose the 1998 for the simple reason we needed to calibrate our model, and in calibrating, of course, we’re looking for the highest peak events, and it happened on February 6, 1998, but there was something else that was important. Here, the reporting stations -- and these are just the DWR reporting stations, we have many others that we’re using -- but these were kind of critical because we’re modeling out in the Delta and we need to calibrate our model based upon what the gauging stations were showing, and it turns out that in 1998, there were 21 stations reporting. And in the other events, some of the stations moved on and off line during the event, so we thought the more data the better and it’s a near 100-year storm event.

We needed land surface models and we needed bathymetry, we needed digital elevation models, and we needed digital surface models, and that’s just an example on the left of the transportation study that was the coverage flown by the U.S.G.S. and I believe also NOAA. And this is the 100-year storm events, and this is a three-dimensional model, and like I said it's hard to show this because I'm zoomed out and what I've done is I've draped over a surface of pixels, I drape the elevation so you can see the Transamerica Building there on the left, and this is down by the waterfront. And this is a 100-year, or near 100-year storm event, very very close. And of course this is what it looks like, I've draped kind of an image to show you and that's the 100-year storm event, you see some inundation taking place just down by the Ferry Building, and the streets are getting wet and the waves are breaking over, but things are pretty reasonable. But then when we add 1.4 meters, we see the inundation starting to go further inland and we see places that are just completely overwhelmed by the water. So we're modeling this at a very very high resolution, we're modeling the water breaking over levees and breaking over barriers, trying to understand what its effect and what its impact is behind these barriers. And for the current studies that we're on now, we're quite interested in whether or not this water, how much it impacts the land, and whether or not there's infrastructure underneath, or there that's going to be damaged. In the case of gas, we're really trying to work out the infrastructure.

In the transportation infrastructure study, we looked at a couple of things. We're interested in the vulnerability of the road network. And, yes, we looked at the airports, we looked at trains, but we also looked at the road and we reeled the model that's out because we were interested in showing not just sea level rise and the impact on the land, but also what impact it would have in the region, as well, so some people would feel, well, I don't live near the ocean, so I should be safe, but of course then they realize that they can't actually go anywhere because the infrastructure gets broken.

And we don't get -- first responder accessibility is kind of important and certainly during 100-year storm events, or any storm event, you want to make sure that first responders can get there. And then we also looked at node-to-node accessibility of the major corridors because if they start to break down, then that's the backbone of your infrastructure and then you need to be concerned there major low corridors are gone. And then we also looked at the Hinterland accessibility to those major traffic corridors because, if you look at these breaking down, then you have a sense of how damaged the system is.

And these are just a couple of examples from that study where you see up in Richmond to the north, and down in the South Bay near Milpitas and Sunnyvale, the gray areas are the areas that are inundated with the 100-year storm event, but with no sea level rise. And here we have sea level rising 1.4 meters and we see up in Richmond, basically that area where the bridge starts is now an island, broken away from the rest of Richmond. And we see that even highways in the South Bay, major highways, are starting to be cut off because they used to be on the land. And those red dots are the first responders, and those are the fire stations. And we see in the South Bay we’ve actually lost two fire stations that are now completely surrounded by water, completely inundated.

The point of this was to try to understand if the first responder system would be broken. It turns out that it’s not so serious because, as you lose land and you lose houses and you lose infrastructure, you also lose first responders and yet you have enough left over. And that just means we did a good job of placing our fire stations strategically so they can keep serving. But it doesn't help in that they've also been impacted.

But if we look at the road network a little further and we look at it regionally, we start to see other things that are not so easily digestible, and one is the domino effect of the interconnected, interdependent infrastructure. We have the node-to-node accessibility and, when we model that out with the 100-year storm event and a zero meter rise, this is just a schematic showing how much extra time it takes to move through the system, and it's not so bad. It just shows one connection between nodes 17 and 18 in the upper left-hand side, that suddenly has difficulty and it starts going four to five times increase in travel time, and that's in the North Bay, and that's the highway going across from Marin to Sonoma, and then a 100-year storm event, it gets impacted. But if we raise the 1.4 meters and we start to do the 100-year storm event, we start to see the system collapse and we are starting to lose major nodes in the system, and suddenly what used to take maybe 50 minutes is now taking six or seven hours, and it's just impossible to move around from one major node to the other. And this is just an example of the cross bay infrastructure that starts to break down.

Looking at the Hinterland, that's how can I get to those major nodes so I can move around, we see those also start to break down, and especially up in Marin County, we can't even move from A to B, we're going to have to redesign that infrastructure and possibly rethink how we're going to move vehicles on roadways around the Bay Area in the future.

Well, let's go up to the Delta because the Delta is a really interesting landscape, very very different than the Bay Area, and it's made up of levees, islands that have earthen levees around them, we have 11 miles of levees, and I could spend the entire day just talking about the Delta. But in this case, we wanted to look at first responders again, but we wanted to look at what happens in the Delta if, in fact, we lose entire islands because in the Delta it’s not just about a levee getting inundated, once it’s inundating the breaks and the island fills up, it could take three, four, five, six months to pump the water out of the levee to repair it -- pump the water out of the island and repair the levee, and that’s because it gets too dangerous to try to patch a levee during a breach. And the technology today doesn’t do a great job. And so talking to the experts, it’s safer to let the islands fill up and then pump it out later.

So on the left-hand side are the number of times, as the patches get deeper red, the number of times that the levees have broken and the islands have been inundated. And I had a bunch of pictures showing lots of water and lots of houses in water up there, but I’m just going to show you maps today.

On the right-hand side is the probability of failure and this probability of failure came out of a number of studies, one that I worked on with Bob Bea here at Berkeley, but also a lot of reports that have come out of the Delta. So we know that a lot of these islands are at risk. Well, what happens? And here is Sherman Island

and here is just looking at a simulation, we're using a simulation model that takes a look at the tides and the wave structure and looks at the surface, both at digital elevation and surface objects such as buildings, and it models the inundation throughout the island.

And so let me just show you the movie, here is the infrastructure and here is the island flooding, and this is what would happen if sea level rose and then the levee breached naturally where the levees were lowest, and you can see it goes in and it basically inundates all the infrastructure, both roads and gas infrastructure at this point.

Now, let's look at the first responders. So, again, looking at the domino effect, and the area on the left is where we had Lidar data, high resolution data, for the entire delta. And the area on the right is the islands that we've flooded, and we've flooded them one at a time, so we did a gaining idea where you flood, and then you recalculate how inaccessible or how accessible first responders are to rescuing people, and you just keep iterating this over and over and over again. And you do this to try to find out, well, who in no matter what scenario who is really in the worst case? And here are the first responders up from the island and, of course, on the right here is the result. Now, again, I could spend an hour talking about this study, but in the end we have these three circles and within these three circles, the people that live here are the people that are living in the worst scenario in that every time islands are flooded, no matter what the scenario is, over the entire reach of it the probability of these people becoming inaccessible to first responders goes up. So that's where you don't want to live on the Delta, or you want to actually start to put first responders in the middle of these areas to possibly help the people.

And so this is again trying to show that the transportation network might break in one place, it might be fine in another, but over a whole series of scenarios these are the places that aren't accessible.

Gas pipeline vulnerability study. So this is Hamilton Field, I told you about the purple lines here are gas pipelines, and this is the end of our study, this is 1.4 meter rise in elevation, and this is the land that is being inundated by the 100-year storm event. What's critical here is those purple lines are the key pipelines that connect north and south. And you can see that one is completely inundated and the other one over there by Highway 101 is also very close to being inundated. So already what our study is showing is that we have a critical piece of infrastructure here, and it's the north/south infrastructure and it's going to be stressed for sure.

Now we use a model called 3Di, the model that the Dutch have been developing, they've developed several innovation models mainly because I think more out of necessity because they spend most of their time living below sea level. And we looked at three of them, and this is the third one, and this is the one that can actually model at very high resolution, very large extents, and does a very good job and this is the one we've been using.

Now, this is what cross sections look like. Here we have sort of a typical area where we have a bit of a levee here, it gets overtopped, the water comes in behind, but then we start going up the side of the higher elevation and you can see these little peaks here might simply be roads or they might simply be certain levees or barriers, but once we start going up it's pretty safe likely to be building infrastructure up in this area. But then we have other parts of the Bay where we have some levees, but then when they get broken, the water gets behind, it keeps breaking, and it goes much further. And here we have a rail line, another rail line and a highway, and we see that even at 1.4 they get overtopped and water gets in behind them, and this area is up north near Suisun Bay.

So those are the two different kinds of edges that we've been modeling. And preliminary results from the Hamilton region, and I'll just run this movie as well, let me go back one here, there we go, and of course the U.S. Corps has already broken a levee and they're starting to make this a wetland, which is probably a good thing because a good wetland will act as a good protective device. But here we are inundating and actually this is the area where we have our gas pipelines, and there they are, you've seen that just a little earlier in this slide.

So some of our preliminary findings, we again used a very preliminary set of runs over a model, not the highest resolution, and we found that we have a lot of pipe segments, about 498 gas pipeline segments, that get inundated, and that's 171 miles. But notice they are bits and pieces of a pipeline and so we're still in the middle of this study, so everything is preliminary right now.

We're talking with PG&E under a Nondisclosure Agreement to understand what the cost of repairing or possibly what their strategy might be to rethink and redesign a pipeline. And that's where we are. So, questions?

MS. CHAN: We're actually going to hold the questions until after both panelists have spoken, so thanks for that presentation and we are going to move on to our second panelist, who is Robert Lempert, who is a Senior Scientist at the RAND Corporation and Director of the Frederick S. Pardee Center for Longer Range Global Policy and Future Human Condition.

DR. LEMPERT: I'm still looking for an acronym.

MS. CHAN: That's a mouthful. His

research focuses on decision making under conditions of deep uncertainty with an emphasis on climate change, energy and the environment. And I’ll pause for an editorial comment there. I know there’s been a lot of bandying about in the process of the word “uncertainty” and “climate change”, and uncertainty is the reason why we don’t take action on things. Obviously, in our everyday lives we deal with a lot of uncertainty and I think another way to think about that is about risks and how we manage risks in our day to day life. I know one of Dr. Lempert’s degrees has to do with science policy, so he’s not only a physicist, but he also has a policy perspective, as well. And he did his schooling at that other school on the East Coast, but we’ll try and ignore that, he studied at Harvard for both his degrees.

DR. LEMPERT: No, no, I was at Stanford for undergrad.

MS. CHAN: Oh, Stanford, okay, he’s cool.

DR. LEMPERT: Okay, great. Thank you very much. And actually I think you guys have done a really nice job of putting together the talks because John talked about a series of risks and vulnerabilities, my talk is going to be how to think about -- and some of those may happen in decades, some of those may be happening now in terms of the shift of storm frequencies, and I'm going to talk about how to think about bringing that information into near term decisions, what we do today.

And so my talk really has two parts. I'm going to talk about a study where we worked with the Port of Los Angeles, helping them think about how to bring information on potential extreme sea level rise into their infrastructure investment decisions. And I'll say specifically what those are when I get to them in a little bit. And the study is essentially a demonstration of an approach for thinking about how to include information on climate extremes into vulnerability and risk assessments. And I'm going to being with an overview of the approach, and then apply it to the Port of Los Angeles.

So, I mean, this is sort of the overview theme that much of our work tries to get at, which is the point that managing climate risk poses both analytic and organizational challenges. As you all well know, and public paneling is supposed to be objective, it's supposed to be clear rules and procedures accountable to the public; on the other hand, if you look at what climate change has in store for us, there's this fast moving, fast changing, sometimes irreducibly uncertain science, competing interests and values, long time scales, though sometimes what seems long is going to come soon, and vice versa, and then the near certainty of surprise.

And in some contexts, it's obvious what you do and you deal with fast changing and surprising worlds, you try to be robust, you try to be flexible, but that's often hard to integrate with our public policy procedures, which are meant to be clear and accountable and understandable to the public.

There is a framework for dealing with this, this is called "iterative risk management," this is a chart from the recent IPCC, Intergovernmental Panel on Climate Change Assessment Report, and basically it suggests going through a process of scoping your decision, doing analysis, implementation and continual updating and revision as we learn. What I want to talk about is how to think about bringing climate information into this process, in a constructive way.

And just to remind you that our climate is changing significantly and in hard to predict ways, this is another chart from the recent IPCC Fifth Assessment Report; much of my work is actually in water, water supply, drought and water management, and so this is the precipitation projections that are in the IPCC Report for two different emission scenarios, low and high, and it shows precipitation globally, and the point I want to make here is that the report looks at 30, almost 40 different climate models, and where the difference in whether it gets wetter or drier in a particular place is larger than the mean.

So in where there’s hatching is we’re not even sure yet whether it gets wetter or drier, which is a particularly gnarly issue for water managers. But this is this concept of we know things are changing, but we’re not sure how. There’s a well-developed body of risk management, but sometimes it is sort of fine-tuned for situations where the uncertainty is relatively limited, and sometimes my colleagues and I stick this name "Agree on Assumptions Approach" where you first lay out what future conditions are going to be and then, using that information, you see what is the best near-term decision, and then you may do some sensitivity analysis. This works great for a number of problems, and I always say you'd never get on an airplane where the people who built it and flew it didn't work really well in this environment and from this sort of method.

In the types of problems that we're often dealing with, this process can go awry, that there's a real pressure to underestimate the uncertainties because if you admit how big they are, then it makes it hard to make decisions. The converse, and I'm sure you're much more familiar with this than I am, is that, you know, policy recommendations are often contingent on a projection, and if you don't like the policy you attack the projection because that's often easier to attack than the policy, and so you can get gridlock. And then a little bit more subtly, we often know a lot about a problem which is not very predictive, but can be very good at distinguishing between wise and less wise policies.

So a way to deal with this in analytics and in forming these risk management and risk assessment issues is, as opposed to going forward, you can go what we call going backwards, so instead of focusing the analysis on everybody agreeing on the assumptions, and from that moving on to the decision, you allow people to come in with different assumptions, but you work hard to use the analytics to help people agree on what to do, even if they believe different things can happen. So essentially the way you do that is you take a set of proposed strategies, you use your analytics to think where those strategies work well and work poorly, from that information you can think about strategies which may work well across a wide range of different futures.

So we have a particular way that we do this which we call "robust decision making" and essentially you go through an iterative loop like this, you structure the decision often working with stakeholders, and I'll get to that at the end, you run your analytics, your models, projections many times. From that, you construct scenarios which tell you the types of futures and which policy may work well, where poorly, we call that "scenarios that eliminate vulnerabilities," and from that you can look at the tradeoffs and work around this process and come up with robust strategies which work well over a range of plausible futures.

So let me take you through this process for the study we did for the Port of Los Angeles, and this was very focused on a particular set of infrastructure, and I'll broaden it at the end, but the particular question we helped them look at is should they or should they not harden their terminals, you know, their big container ship terminals against extreme levels of sea level rise at the next upgrade. And essentially every period of time, it's been every few decade or decade and a half in the recent past, they do a major retrofit of these large terminals, and at that time it's relatively inexpensive to put in hardening against an extra meter of sea level rise; but if you don't do it then, it's really expensive to respond. So should they, given things like the West Antarctic ice sheet that's beginning to crack, and so sea level may got up much faster than we think, should they or should they not do it? And so we give the little arguments here, “it’s much less costly if we do it now, why don’t we prepare” versus “this is really an unlikely event, why should we buy the insurance?”

So we set this up very simply as a benefit/cost calculation, the costs are well known, it’s the engineering cost of hardening the terminal, which basically has to do with pulling the wires and cables up a little bit higher, and so forth. The benefit is a little bit harder to determine because it depends on whether or not we start getting extreme levels of sea level, whether the sea level begins to rise much faster than expected at the high end of the numbers that John quoted, or even higher, and that we don’t know. So we have a very simply cost/benefit model which depends on two sets of things, and let me just lay them out here, what’s called in the risk world the “hazard” which has to do with how the climate is changing, we looked at the two things that John talked about in his study, which is how much do the seas rise, and so there’s both the thermal expansion of the oceans which is relatively well known, that’s a process people understand well, and then there’s the fracturing of the Greenland and Antarctic ice sheets, which people don’t understand nearly as well, and does that accelerate? Does that take off?

And then there’s this change in storm surge frequency, you know, this 100-year storm that’s become a 50-year storm, that’s become the 30-year storm, how does that change? And so that’s the hazard. And then in thinking about what you need to do now, that connects with what’s called the “vulnerability,” which has to do with how long is this piece of infrastructure going to last? Okay, when is the next upgrade? And then what risk of annual flooding can we tolerate before we need to spend significant money to respond?

So if you knew each one of those things, you could stick into a relatively simple cost/benefit model and calculate the net present value and decide whether it passed the cost/benefit test to buy this hardening or not. And this is all laid out, that’s the reference for the paper where this is.

But the fact is, we don’t know any of those things for sure and so what we do is we look at a wide range of terminal lifetimes, a wide range of essentially disruption costs that people could deal with, we look at a wide range of different sea levels, essentially the range John looked at plus a meter, and a wide range of storm surge or change in the frequency of the storms.

So this little graphic suggests what we chose to do, we essentially take 500 different plausible futures, 500 different combinations of vulnerability and hazard, so some with very extreme sea level and very invulnerable terminal, and vice versa, in all different combinations, you run it through the model, you get these many hundred futures, and the first point to make is that this helps reduce gridlock because if you have people, you're showing the analysis to people who have different expectations, and not surprisingly often people's expectations correlate really well with their policy preferences. You've got their expectations in the model, so it gives much better buy-in to this analysis.

This then lays out in a chart the answer for each of the cases we ran, so for most of the cases the benefit/cost of this infrastructure investment is negative, so it’s over on the left, and if you’re over there the best thing to do is just be reactive, not make this proactive investment; if you’re on the other end, there’s this long tale of cases where this investment pays off -- sometimes big time -- and if you’re there you should make the investment.

So now that’s somewhat helpful, but the key question is, what distinguishes the ones to the right of the line from the ones on the left of the line? So it turns out this is just a big database of cases, you can do some statistics on it, and it turns out if the terminal lifetime is at the very far end, about 75 years or longer, if the abrupt sea level rise is fast, and this is a combination of when it accelerates and how fast it accelerates, but essentially if it happened soon it would be about 14 millimeters a year. And then how much does the change in the frequency of the storm, and if that changes just a little bit, and it turns out that it really doesn’t matter how sensitive they are to future flooding, that turns out not to be important at all for this analysis. So if those three things happen, then you ought to harden at the next upgrade; if not, not.

So one important thing to note is that, in this world of uncertainty, this is actually a really concrete thing, you know that for sure, okay, even if you don't know the probabilities or anything, so this is a concrete bit of information. Now, should they harden at the next upgrade? Okay. So now we have to think how likely might that vulnerable scenario be, that set of conditions where you would harden, and here is where we can now start mining the climate science and other information to see what we learn. So given the shape of those cases, it turns out you need the conditions that I showed you on the previous slide to be more than about seven percent likely, so a little bit less likely than about one in 10 if they are, so if they are a little bit less likely than one in 10, you should buy this upgrade.

So I won't go into the details of this, but we took a variety of different bounding cases, including some of the information that John talked about, some of the California State Guidance, a couple of other studies, and you fit some statistics to that, and it turns out that these extreme rates of sea level rise are no more than -- it says 16 there, but no more than about 15 percent likely, so it’s hard to make a case that they would be any more likely than that.

And there really isn’t much experience with the terminals lasting anywhere near 75 years, they’ve been more like 20 years, and at the time we did this, and I think it’s changed a little bit, but not that much, there was really no evidence to suggest that you would get storm increase frequencies. So for this particular investment, it turned out that it was probably appropriate not to buy this insurance. We looked at a variety of different facilities in the Port of LA and there was one, a bridge, which would both likely last longer than the terminals and was lower down, so that was one that it might make sense for them to go to their engineering feasibility studies and do that. And then there’s a variety of parts of the Port, the rail lines and things like that, that they would probably need to worry about. But for this particular set of infrastructure, this was the answer.

So this was a very sort of one-dimensional case where we looked at just one of the pieces, so John showed a whole bunch of different pieces of infrastructure, this was just one, but gave a sense for what the implications for sea level rise for things you're doing now. We've done the same sort of approach in a whole variety of different contexts with much richer sets of options, and so I list a couple of them here, and particularly the Bureau of Reclamation Colorado River Basin Supply and Demand Study where California participated with the other six parties of the Colorado Compact, and that looked at hundreds of different supply options and went through a process like this and came up with a sorting of what you needed to do now and then what could be deferred until later with climate change. This sort of process underlies the recent Louisiana Master Plan for a Sustainable Coast, a bunch of World Bank -- I should have put the -- we do work like this for the Department of Water Resources for the State Water Plan, and then some work in Jamaica Bay. And this is just a picture of -- the main point here is that this sort of process is very powerful in helping people who have reasons to disagree with one another, to come to consensus on where their vulnerabilities lie, where their strengths lie, and coming up with plans that are well matched and robust across a wide -- and having people come to consensus on it -- that are robust across a wide range of futures. Often by starting with a plan, having clear signposts that they're watching which are tied to these vulnerabilities, and having clear contingencies that people can agree to take if those signposts are reached.

Just a quick summary, that you often need integrated and adaptive plans to deal with these sorts of risks and this idea of running the plan backwards, stress testing proposed plans over many futures can have a variety of beneficial effects. So thank you.

MS. CHAN: Thank you. So I'm going to start with a couple of just mechanical or clarifying questions for Professor Radke and then I have some more provocative questions, and then I'd like to open it up for the panelists to ask each other questions. I find that sort of illuminating every once in a while.

So Professor Radke, I know you had made

reference to a couple things in passing and I just wanted you, for the benefit of our audience, to explain them a little more; you made passing reference to a bathtub model versus a more dynamic model, and I was just hoping you could say a few words to explain that. And also, you made passing reference to the fact that wetlands could be an excellent way of addressing flood risk, and I was hoping that you could speak just very quickly to give us a little more detail on that.

PROFESSOR RADKE: Okay, is my microphone on?

MS. CHAN: Yes.

PROFESSOR RADKE: Okay. Yeah, as opposed to a bathtub, or a more dynamic model. So bathtub models, and a lot of people use them, they're quite easy, you just raise the elevation of the seal level, and of course you raise that level to whatever is being predicted. And so if it's 1.4 meters, you just raise it 1.4 meters and see where water inundates. The problem with doing that is that it doesn't account for the movement of water. And so we went to a pathway model and we looked at not just a digital elevation model, which most people use, we integrated something called a digital surface model, and those are the objects on the surface, and we use those to watch the water track its way across the landscape. And at times they're really good barriers either built by humans, or sometimes natural barriers that actually prevent the water from inundating and therefore prevent damage and prevent infrastructure from being impacted. So in our transportation study, we went with this pathway model.

Then, you know, we had some great feedback that said, well, why not go with a dynamic model? And we started playing with dynamic models, but the problem is, you know, I'm trying to model areas larger than the entire country of the Netherlands because California is a really big place, and I'm not only trying to do that, but trying to do it right down to the curb level. To try to get a better sense, so I hope one can even think of how much processing this takes in the model, it's a lot of computing, but just to try to make good exact solutions and correct solutions, and trying to get it right. So the inundation models, they not only look at the tides, they also look at the wave action, and that's why we needed to go out and not just predict some elevation, 2.60 which was the 100-year storm event, but we also needed to be able to look at gauging stations that are all over the Bay and Delta areas so that we could better calibrate our model as we were looking at this impact. And so that's why we've come up with this newer model. Now, there are lots of models that you can use to model very tiny areas if you're trying to put in a dock, or you're trying to just do a little bit of change in the landscape, but to model the entire Bay, the entire Delta, has been quite a challenge -- an interesting challenge, and we feel we're getting some good success from doing that.

The second question had to do with wetlands -- and let me go back to the first question first -- so we also found that there are objects on the landscape, the digital surface model, that do impact the inundation of water, and if you use the bathtub model, there's not really an impact, and actually if you just use a pathway model there's not a huge impact, as well, objects like buildings do impact the movement of water and the flow of water. And so we actually have had to rebuild our surface model to include every building and every object and this vast area called the Delta in the Bay, and it's been quite exhausting. But, you know, the fact is we're getting much better results and much more real results so that we have a better sense of what will happen. And I really appreciate what Robert Lempert was suggesting and saying, you know, that the closer you can get a sense of what's going to happen, and if you can do this well in advance, then this kind of planning and decision making can be enlightened and we can actually do a much better job at minimal cost. And I just want to go on record by saying if you gave me 90 years to plan something, I could plan it at minimal cost, at minimal expert cost, because I'd have 90 years, and I'd understand that some things might have a life of 75 years, other things might have a life of 50 years, so it really helps us rethink, redesign our transportation infrastructure in an intelligent way because we know what the future is going to bring eventually.

The second question was wetlands and this is where the Dutch have learned an awful lot and we can learn from them, that in about 1100, they used to pump water, they used to build levees because they were under sea level, and they would pump the water out and they would dry the area out, and then they noticed that they were getting subsidence and the subsidence exacerbated the problem of being below sea level, so they were actually sinking. And then it took them 100 years, so by about 1200, they realized that what they needed to do was keep all of these canals and channels, many of them, and keep them full of water to keep the land moist and to keep the land at somewhat of a constant elevation. And we have a similar thing going on in our Delta in that we have incredible subsidence and some of those islands, there's places on Sherman Island that are 24 feet below the river level, but they didn't start off that way, they started out at river level.

And the idea of wetlands, and I suggested that the U.S. Corps had just broken a levee at Hamilton Field and they're trying to create a wetland, and wetlands act as good nature barriers because, as water rises, hopefully the wetlands will grow and the Dutch are trying to do this with some of their levees, as well, they have what they call "horizontal levees," and they try to get these areas to grow, they're very gradual levees, they grow and through time they become less risky. If we build a concrete levee and it's a certain elevation, it's not going to grow, it stays that elevation. And through time, of course, as sea level rises and inundation increases, they're just going to get overtopped. And we can see that in Fukushima, you know, the levee never anticipated the tsunami and it was overtopped quite easily and that levee took very little energy out of the wave, and the wave was incredibly destructive behind the levee. And had we been thinking more green here, and put more vegetation in place, or in that case left vegetation in place, it would have served to take energy out of that wave.

Up in Sherman Island there, the western part of Sherman Island flooded years ago and they chose not to rebuild the levee, so it's turned into a wetland, and it acts as a good barrier to any storms because the wave action comes in and it hits this wetland and takes the energy out of the waves, and therefore there's less inundation and less stress on the actual levee on the western side of Sherman Island. And we're finding more and more that growing things is a good way to calm these forces.

MS. CHAN: And I know we're just pretty narrowly focused today on sea level rise impacts on transportation, and we're not talking about heat or other climate risks, and we've heard a little bit about wetlands and a little bit about hardening, we haven't had a chance to touch that much on a couple other management options that Professor Radke discussed about changing location, and also design, which are also fruitful topics, which maybe if we have time we can touch on a little bit. But I did want to circle back to Dr. Lempert and ask a question.

COMMISSIONER SCOTT: Ann? I was just going to check; before you go to Dr. Lempert, I had a clarifying question also for Professor Radke and I was just going to check and see if my fellow Commissioners did.

Professor Radke, thank you very much for your really interesting and informative presentation. The question that I have for you is, you mentioned two or three times actually I think that the Global Circulations Model show that the 1.4 meters is going to be where we're anticipated to be at the end of the century. And so I was wondering why you stopped your modeling at 1.4 instead of potentially looking at some scenarios that might be higher than 1.4.

PROFESSOR RADKE: Yeah. Good question because -- so I didn't also talk about the specific Pacific Decadal Oscillation which is, you know, it's like this huge -- the Pacific is this huge bathtub and it sort of oscillates back and forth about every 15 to 20 years, and so right now in San Francisco we're experiencing really low sea levels, but in fact they're at average because it's very very high out in the Western Pacific. And in the next 10-15 years, it's going to oscillate back, so we're going to feel like sea level is really rising rapidly because it will just be sloshing back toward us. And I know that there are lots of people -- I took the average because, I don't know, maybe the fear of people screaming at me, I don't know, but if you take the extreme, the extreme actually might actually be correct, and now that we've seen what's happening in Antarctica, it makes me nervous, I'm very nervous about that, but I took 1.4 because that seemed to be the average model and that's what people were saying would likely be. But I also said it would likely happen by 2100 and the fact remains, if we stop burning fuel and we stop putting carbon in the atmosphere, I think we're still going to get this effect of 1.4 in 2100. But we did it as 0.5, 1.0, and 1.4, and we could have kept going because that level might come earlier or it might come later, but we feel pretty confident that it's going to happen. And again, if I had 90 years to plan, and I really appreciate what Robert Lempert had to say because it is important to look at, well, what am I trying to protect? And am I trying to protect something that is built? And if it's built and it has a life expectancy of 75 years, then maybe I shouldn't be too concerned about it. But we could have kept going on and modeling higher and higher to 2.0 and 2.5, etc. And I just doing know that it's worth frightening people. And it's a long way off and I was hoping, I guess, that 1.4 was what people are agreeing on, and I also felt that 1.4, whether it's plus or minus, whether it's plus or minus 10 years, would at least get us to understand that we could actually make changes now at very little cost because rather than repairing 880, spending hundreds of millions of dollars repairing 880, next time rethink 880 -- and that's one of the highways that's inundated around San Jose -- rethink where we're going to put it and spend our efforts redesigning the Bay Area so that in 90 years we don't have to worry about infrastructure getting inundated, constantly getting inundated and constantly costing money. So that's why we did what we did.

COMMISSIONER SCOTT: Great, that's very helpful, thank you.

MS. CHAN: And I guess I'll jump in by saying the Safeguarding California Plan references the National Research Council Report that the state invested in with Oregon and Washington, and the projected numbers in there are actually slightly different, the range that's provided for 2100 is actually anywhere from 17 inches to 66 inches, so it actually goes past the 1.4 meter point.

As Professor Radke points out, the

further out you go, the more risk and uncertainty there is associated with those numbers. But we're also trying to design our policies here in California for sea level rise to take into account the fact that we don't think it's going to stop.

CHAIRMAN WEISENMILLER: Okay. I also had a question. If you turn to page 7 of your slides, you showed Richmond, and I guess what I was looking at was just mentally where the refinery is now.

PROFESSOR RADKE: Yeah, let me find my slides here. I'll find them. Richmond, right?

CHAIRMAN WEISENMILLER: Yeah.

PROFESSOR RADKE: Yes.

CHAIRMAN WEISENMILLER: Keep going.

PROFESSOR RADKE: Okay. So I've got Richmond.

CHAIRMAN WEISENMILLER: Yeah, so you've got Richmond before and after, and it's roughly -- I've got two slides per page, so page 7 --

PROFESSOR RADKE: Yes, I see it.

CHAIRMAN WEISENMILLER: So it's probably about 13 or 14.

PROFESSOR RADKE: Right, page 15-16, I'm

looking at it. Did you want to put those up on the screen?

CHAIRMAN WEISENMILLER: Yes.

PROFESSOR RADKE: So can I share my desktop?

CHAIRMAN WEISENMILLER: Sure.

PROFESSOR RADKE: Okay.

CHAIRMAN WEISENMILLER: Okay, so basically the question is where is the refinery? Particularly as you go through the high storm stuff, it appears the refinery is under, well, at least being flooded.

PROFESSOR RADKE: Part of it is being flooded, right. But remember, I think the refinery actually is to the eastern side of these hills.

CHAIRMAN WEISENMILLER: Okay.

PROFESSOR RADKE: So this area is pretty low lying.

CHAIRMAN WEISENMILLER: Right.

PROFESSOR RADKE: Yeah. And here’s the bridge part here. Okay, so what’s your question?

CHAIRMAN WEISENMILLER: Yeah, so basically trying to figure out in terms of critical infrastructure, you know, we looked a lot at sort of highways and all, but sort of either refinery location, or oil pipelines, how much have you looked at those?

PROFESSOR RADKE: Well, so we are looking at gas pipeline infrastructure right now and working with PG&E under a nondisclosure to try to understand their infrastructure, and the graphics that I showed were from the National Pipeline MTMS Mapping System, but we also have the liquid pipelines and we actually have discussed -- because we're trying to understand what the cost of replacing and what the strategies are, not just the strategies, but what the costs are of replacing pipeline infrastructure. And we've also tried to encourage those that we're talking with to also help us with the infrastructure such as at the refinery plants and pump stations and on the ground infrastructure, as well. And they so far have been cooperating and we've been getting where their critical infrastructure on the ground is. And at the end of this study, hopefully we'll know which areas are at great risk and which areas are not.

CHAIRMAN WEISENMILLER: Yeah, because the example we're looking at with transportation, one of the questions is which of our transportation infrastructure is going to be impacted. Obviously, oil is a key part of the transportation system or a larger part than natural gas at this stage.

PROFESSOR RADKE: Well, our whole point about interconnectedness is that, you know, both of them impact each other. Certainly if oil can't come into the Bay Area and be refined, we've got an issue and we've got a problem. We actually haven't inundated with our new model the area around Richmond, and up in Martinez, but we will. And of course, with our modeling looking at transportation we think Martinez looks pretty risky. But oil is also transported by rail, as well, so certainly it is expensive to bring it into the Port of Richmond, and all we can do is point out what pipelines will be impacted. It is certainly up to the pipeline managers and owners to decide how they're going to deal with what we've predicted as being an impact to their infrastructure. So I don't know if that means – I don't know what that means. We're still modeling and we're still trying to get back to them with what parts of their infrastructure will be impacted, when, and some of it will be permanently possibly underwater and others will just get impacted by the inundation from an extreme event. And so we're right in the middle of that research right now. I wish I could tell you the answers. I don't have the answers yet.

CHAIRMAN WEISENMILLER: No, and some of these locations obviously have been refinery sites for well over 100 years, so in terms of potential toxics on the site, it can be relatively high.

PROFESSOR RADKE: Well, that's true. That's true. You know, the concern in New Orleans was that there was 139 miles, I think, of pipeline that had been inundated after Katrina for several months before they were able to pump the water out. And I guess they checked some of the wells and they'd been compromised. So they quickly changed out the pipe. And we don't know how they're going to respond, we're still processing so much every day so we can get them predictions of what's going to be inundated so that they can take a look and make decisions about how they might handle that. The very last slide, if you go to the very last slide, we show this fragmentation of inundation, and all those little red chunks -- and this is just a preliminary model, not at the highest resolution, and you're seeing bits and pieces of all those pipelines being overtopped, or at least at some point they're being impacted. And we don't know what decisions they would make how to change that. They do have -- pipelines do go underneath the Sacramento River and they do go underneath the Bay, but they're special pipelines rated and designed to be permanently underwater. But anything that is up on the land, although it's wrapped so that it shouldn't have saltwater intrusion and it shouldn't be compromised, they were concerned about the weight, the weight of water and the slushing around, the water on top of this pipeline, and they showed great concern and that's something that we weren't concerned about going into the meetings with the pipeline operators, but coming out we realized it was something we hadn't anticipated.

CHAIRMAN WEISENMILLER: Thank you.

PROFESSOR RADKE: Does that answer your questions?

CHAIRMAN WEISENMILLER: Yes.

PROFESSOR RADKE: Thanks.

MS. CHAN: All right, this is Ann again and I had a question mostly directed to Robert, but open to both panelists. I know we had the Port of LA study that you showed and you talked about it in terms of whether or not you want to buy that insurance if you run the model and it comes out a certain way; so I'm going to ask a question about multiplicity of actors in the system. So obviously we have lots of earthquakes in California and we can think about it in sort of a similar way, earthquakes, somewhat low probability, but very high catastrophic costs when they actually do have them for any individual actor or anyone managing a certain asset may not make sense, but societally if we get hit with one of those, we still need to figure out what to do, disaster appropriations, that kind of thing. In terms of climate change risks, we're seeing things like the National Flood Insurance Program really decimated by these increasingly frequent megastorms, as they're called. So I wanted to see if your models or your studies have looked at multiplicity of actors, particularly for those of us that work in the policy arena and set state policy, also working with our federal partners on federal policy looking at it from more of a public policy standpoint, if you could speak about that. Thanks.

DR. LEMPERT: Yeah. The quick answer is yes, and we have. I think there's actually two pieces to your question; I mean, one is the timelines and the other is essentially sort of multiple assets at risk, and so one of the drivers in the Port of LA study that I showed you is the interplay between the lifetime of the capital stock and the sea level rise, which is I think very different than earthquakes, which could happen at any time.

MS. CHAN: Right.

DR. LEMPERT: But on the multiplicity of actors, yeah, that was a central feature of all the pieces I showed you on my final slide. So since we were discussing, you know, the Louisiana Coast, we talked about that, which was that study basically took flood maps like we've been looking at and then played many hundreds of combinations of different, you know, wetlands restoration versus levees, and so forth, and basically played out many hundreds of combinations of these things within essentially the $50 billion amount of money that the State of Louisiana had to spend, in interaction sessions with stakeholders, basically the state they're head of, and office which was responsible for the coastal plan, and so they had about 30 or 40 representatives with basically monthly meetings for about two years, which were essentially interactive what ifing, you know, what happens if we take the money from this levee and put it here, well, that protects this parish, but the levee here will increase the flood risks on the neighboring parish, so maybe we ought to add a little bit of wetland -- so basically interactive designs of these things to come up with something, which ended up passing the Legislature unanimously because it had this ability to balance these competing interests, not only flood protection, but recreation, keeping their ports safe, the fisheries, so there's a whole bunch of competing interests, competing people, and then playing that out against a range of different sea level rise and storm surge scenarios so that you're basically giving everybody a reasonable tradeoff with a wide range of different potential stressors.

So, yeah, dealing with multiple interests is definitely at the heart of this. And clearly in the Colorado Basin Study, which there's clearly up river and down river, high water rise and low water rise, and so that has to balance among those, as well.

MS. CHAN: Sure. So having seen John's presentation, is there anything that you would want to ask him, or that you found provocative?

DR. LEMPERT: Well, let me start with a really techy question, which is: John, how long does it take to run a case on your models? And how hard or easy is it to shift things around? You move pipelines, you know, add a little bit of wetlands, and so how easy would it be to play this game of seeing how your policies might evolve over a couple of decades to protect against some of the risks you showed?

PROFESSOR RADKE: Yeah. Is my mic open? Okay, so I started off thinking that I could get by with eight terabytes of disk, and I was just fooling myself. And now we're looking at just every researcher carrying a terabyte in their pocket, I think. So it's a lot of modeling and it takes a long time and we've been trying to design computers here that will go faster, but it tough, it is tough. And this is why, if you've got One Scale, it's easy to model, but you're missing the subtleties, and my whole point was at One Scale you miss critical levees, and some of the natural levees that actually protect the landscape; the one slide that I showed, that if you do it one way you miscalculate and you over-flood the areas. So it takes a long time and the transportation study that I did on the Delta that was just looking at first responders, so basically what I did was I had every first responder respond to every household in the Delta after an event took place, and it would run about two weeks, maybe less than two weeks, on each flooding of each island, and of course, we assembled it altogether. So it takes a long time and you have a dedicated server to do that. So the processing takes a long time.

Now, the idea of the scenario of changing some infrastructure, it turns out that that's not that difficult because we sort of, oh, we learned the hard way, we were all set, we had our models ready to go, and we were feeling very proud, and we brought in an expert hydrologist from the Netherlands, and we took him out into the Delta and he just looked around and pointed out all the things that we had done wrong to run their model. And part of it was we had dealt with education in sort of an incorrect way, and so we were able to then quickly change our strategy and started to remove vegetation, and start to remove things from our surface model, which means we became sort of expert at running out different scenarios. But it turns out that that is something that is real, so if a design group said, “Wait a minute, what if we make these changes and the following could be built, and the following could occur, what would be the result of that?” And it turns out we could do that, it’s not difficult anymore simply because we’ve gone through that entire process of just trying to get it right, the modeling in the first place. I don’t know if that answers your question. We’re still trying to tune -- GIS is easy when you don’t have massive databases, and when you get massive databases it gets harder and harder and you have to start to rethink how you solve a problem and redesign the solution, the algorithm solution. So, yeah, I'm exhausted.

DR. LEMPERT: Okay (laughing).

PROFESSOR RADKE: I'm thinking back to a time where I said, "I don't think I want to do this," but anyway, I'm glad that we did it.

MS. CHAN: I know we have a lot of folks with us in the audience, I want to kick it back to the Commissioners to see if they have any last questions before we open it up.

CHAIRMAN WEISENMILLER: Yeah, I have one. So on your list of the conditions where basically they pass the cost/benefit test, I was surprised the discount rate didn't get in that.

DR. LEMPERT: Oh, yeah, we didn't vary that and, had we, it would have. In this particular problem, it would get tied up with disruptions and how much you thought it would disrupt operations and such in the future, so we basically assumed in this particular study that in the future you would have enough warning to do an orderly hardening of the terminal in the future, so it was essentially -- it was only cost of capital and not sort of the social costs of running a problem. So we basically -- the short answer is we set up the problem to make that much less of an issue than it is in other cases.

CHAIRMAN WEISENMILLER: Okay, thanks.

COMMISSIONER SCOTT: I did have a question of you also. You mentioned that the one process where you showed all the folks sitting around the table together, and that took about two years, and how long did the port process take? And, then, if you were to do this with other sort of critical pieces of infrastructure around the state or other areas, is there a typical timeframe for how long it takes?

DR. LEMPERT: Yeah, the answer is no, it depends; the two years was much more of a social process, so with the port it was much quicker, we did four small workshops with them and the calculations were much quicker. For individual pieces of infrastructure, you know, I mean I think it’s a pretty quick process, it depends on if you’ve got a model which looks at the performance and you’ve basically got a pre-feasibility study, or something like that, that’s sort of a few weeks, and then the rest of the time would be the social process, depending on how much of the community you wanted to bring in.

COMMISSIONER SCOTT: That’s great. Thank

you. Well, so I would like to say just a hearty thanks to Deputy Secretary Ann Chan for being such a thoughtful moderator and to both Professor Radke and to Dr. Lempert for just really interesting, I think, fascinating and well researched information and your presentation of them here today. So thank you very much for that.

MS. CHAN: Thank you.

COMMISSIONER SCOTT: I'm going to open it up to see whether or not we have public comment and turn to my IEPR team to see if we've got any blue cards.

MS. RAITT: I didn't receive any blue cards, but is there anyone in the room who wanted to make comments or have questions? No. And then on WebEx, I don't think we have any questions. We do have on person on the phone and we could open up that phone line and see if that person has a comment. Okay, it's open. If you're on the phone, this is your opportunity to make a comment or ask a question.

MS. SCHMIDT-POOLMAN: Yes, hi. This is Martine Schmidt-Poolman. I actually had a question for Dr. Lempert about the stakeholders and whether he has an idea based on working with them on how aware they were of this, I guess what you also noticed, this inter-connectivity of the various infrastructure around the ports. Did you notice that they became more aware, or weren't aware?

MS. RAITT: Oh, and I'm sorry, so could you also give us your name and affiliation, please?

MS. SCHMIDT-POOLMAN: Oh, this is Martine Schmidt-Poolman and I work at U.C. Berkeley.

MS. RAITT: Thank you.

MS. SCHMIDT-POOLMAN: And I work with John.

DR. LEMPERT: Okay, great. Hi. Yeah, that's a great question. The Port of LA stay was actually very limited and we just worked with people within the port design team, but on some of the other work I mentioned, some in Louisiana and the Colorado Basin, yeah, no, part of the exercise is helping people become more aware of the interconnectedness. I mean, putting a levee in one place may reduce flood risks behind the levee, but may increase flood risk for the next people down the coast. And again, part of the two-year social process is people becoming much much more aware of that and in some sense starting to get an intuitive sense with how that works, so that they can better adjudicate and negotiate with one another about the tradeoffs and how they work, and the model essentially informs their ability. So, yeah, you do see people becoming much more cognizant of that as you go through the process.

MS. SCHMIDT-POOLMAN: Okay, great. Thank you.

MS. RAITT: It turns out we have two questions also coming from WebEx by write-in, so I'll read those out loud. The first one is: What bridge at POLA needs to be replaced according to the RAND study? And the second question is: What is the Vincent Thomas Bridge? And those questions are from Jerilyn Lopez-Mendoza at SoCal Gas.

DR. LEMPERT: The bridge that we looked at, we didn't say it needed to be replaced, we said that when it came time to do its upgrade that the Port might look at more detail, you know, that it passed essentially the screening test that they ought to take it seriously, so it's the Alameda and Harry Bridges Crossing is the name of that particular piece, that bridge was the one that they ought to pay attention to.

MS. RAITT: And the other question was: What is the Vincent Thomas Bridge?

DR. LEMPERT: That's the big one across the Port of LA and the Port of Long Beach.

MS. RAITT: Thank you.

COMMISSIONER SCOTT: Can you mention that into the microphone?

DR. LEMPERT: Unless I'm remembering wrong, that's the one that connects the Port of LA and the Port of Long Beach, right?

MS. RAITT: Okay, I don't think we have any more questions.

COMMISSIONER SCOTT: Okay, well I would again like to reiterate my thanks to our IEPR staff and to the Energy Commission staff that helped put together this really interesting workshop. Thank you again to our terrific speakers, I thought that was just really informative and I learned a lot, it was very interesting, and to Deputy Secretary Chan for being a terrific moderator. And from my perspective here, I would reiterate what the

Chair mentioned at the beginning of the workshop, which is that our transportation sector is responsible for about 40 percent of the greenhouse gas emissions here in the State of California, and so ratcheting those down is going to be of utmost importance. I think for the last few workshops that we’ve had so far on the IEPR, a lot of the speakers have discussed the urgency for getting these reductions in place and, in addition, getting clean air pollutant reductions in place from the transportation sector. And I think that the presentations we got here today just put a really fine point on the climate imperative for why we need to do that, and so I would thank you again and see whether or not either of my fellow Commissioners has any closing remarks for today.

CHAIRMAN WEISENMILLER: Again, we were certainly sorry to have missed the third panelist, but certainly encourage sort of that written submittal and again going forward, if people have questions or comments, I don’t know if there’s a period when comments are due, Heather?

MS. RAITT: Yes. Comments are due June

7th.

COMMISSIONER DOUGLAS: Great. Well, I'll just join Commissioner Scott and Chair Weisenmiller in thanking the panelists and Ann Chan for moderating, and the IEPR staff for helping pull this together. It was very informative and we'll look forward to more workshops on reducing emissions and otherwise providing benefits from the transportation sector.

COMMISSIONER SCOTT: We're adjourned.

(Whereupon, at 4:37 p.m., the workshop was adjourned.)

--oOo--

REPORTER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were reported by me, a certified electronic court reporter and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 4th day of June, 2014.

PETER PETTY
CER**D-493
Notary Public

TRANSCRIBER'S CERTIFICATE

I do hereby certify that the testimony in the foregoing hearing was taken at the time and place therein stated; that the testimony of said witnesses were transcribed by me, a certified transcriber and a disinterested person, and was under my supervision thereafter transcribed into typewriting.

And I further certify that I am not of counsel or attorney for either or any of the parties to said hearing nor in any way interested in the outcome of the cause named in said caption.

IN WITNESS WHEREOF, I have hereunto set my hand this 4th day of June, 2014.

Karen Cutler
Certified Transcriber
AAERT No. CET**D-723